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ALLOCATIVE EFFICIENCY OF RICE PRODUCTION BY SMALLHOLDER WOMEN FARMERS IN IGABI LOCAL GOVERNMENT AREA OF KADUNA STATE, NIGERIA.

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ABSTRACT

A primary obstacle to food security in Nigeria is the low productivity of most staple food crops and the efficiency with which the farmers use the limited available inputs. These have threatened the effort of the Nigerian government towards food security. Therefore, this study examined the allocative efficiency of rice production by smallholder women farmers in Igabi Local Government Area of Kaduna State. Primary data were collected through the administration of questionnaire. A multistage sampling technique was used to select 100 respondents from five wards and ten villages. Production and socioeconomic data obtained using structured questionnaire were analyzed using descriptive statistics and stochastic frontier model. The study revealed that most of the farmers were youths with the mean age of 40 years. Majority (72.5%) of them were married, had tertiary education (40.7%) with average income of ₦200,333.33. The result of the stochastic frontier model revealed that labour cost (ß = 0.243; P<0.05), seed cost (ß = 0.218; P<0.01), transportation cost (ß = 0.141; P<0.05), fertilizer cost (ß = 0.001; P<0.01) and land rent (ß = 0.031; P<0.05) significantly influenced the cost of rice production. Also, age, education, household size and credit facilities influenced the women farmers allocative inefficiency. The women farmers list of constraints showed that inadequate processing facilities ranked 1st.

Keywords: Allocative efficiency, income, women, production, constraints.

Introduction

Rice (Oryza sativa) is the world's most important food crop, being the staple food for over 50% of the world population (Akinniran and Faleye, 2020). It is one of the Nigeria major cereals that have assumed cash crop status since it plays a crucial role in contributing to food security, income generation, Poverty alleviation and socioeconomic growth. Nigeria has the potential to be self-sufficient in rice production since virtually all the ecological zones are suitable for its cultivation either as swamp, upland or under irrigation (Toba *et al*., 2022). Nigeria, despite producing approximately 2 million metric tons of milled rice annually, relies heavily on imports, with an estimated 3 million metric tons imported yearly (FAO, 2020).This significant gap has led to Nigeria becoming the largest rice importer in sub-Saharan Africa (Ojumu*et al*., 2024). To address this gap, various initiatives have been implemented to enhance rice productivity along the value chain. These efforts include the Anchor Borrowers Scheme, the Agricultural Transformation Agenda Special Programme (ATASP), and other international projects (Omolehin*et al*., 2019). Rice farmers often exhibit high price efficiency (above 0.90), particularly when

supported by credit schemes like the Anchor Borrowers' Programme (ABP) or Commercial Agriculture Credit Scheme (CACS), enabling them to choose the right, cost-effective input mix (Nwahia, *et al*., 2020)

Efficiency is concerned with the relative performance of the processes used in transferring given inputs into outputs. Farrel (1957) identified three types of efficiency-technical, allocative and economic. The concept of allocative efficiency is related to the ability of a farm to choose its input in a cost minimizing way. It is meant to assess the ability of farms that are technically efficient to produce at the least possible cost. An important assumption relating to efficiency measurement is that firms operate on the outer bound production function, that is, on their efficiency frontier. When firms fail to operate on outer bound production function, they are said to be technically inefficient. The stochastic frontier production function, which is often used for efficiency studies was first independently proposed by Aigner *et al*. (1977) and Meeseun and Van Den Broeck (1977). It comprises a production function of the usual regression type with a composite disturbance term equal to the sum of two error components. One error component represents the effects of statistical noise (e.g., weather, measurement error, *etc*.). The major advantage of the model is the introduction of disturbance term representing noise, measurement error and exogenous factors beyond the control of the production unit in addition to the inefficiency component. This property of the stochastic frontier model accounts for its appropriateness for efficiency measurement in agricultural production owing to agriculture's inherent characteristics.

Agriculture remains a major source of livelihood in Nigeria, particularly in rural communities where women play a critical role in food production. In areas such as Igabi Local Government Area of Kaduna State, women are actively involved in rice farming, contributing significantly to household food security and income generation. In spite of their contributions, these women farmers often operate under challenging conditions, including limited access to productive resources, inadequate extension services, poor access to credit facilities, and cultural constraints that restrict ownership and control of land.Despite the availability of cultivable land area, rice production has failed to meet local demand thus resulted in increase in Nigeria's food import bill (Senuga *et al.*, 2020,). In view of the foregoing, the study aimed at addressing the gap by examining the allocative efficiency of women rice farmers whose efforts are often neglected.

Efficient allocation of available resources (land, labour, capital, and inputs) is essential for improving productivity and income in rice farming. However, there is growing concern that women rice farmers in Igabi may not be achieving optimal allocative efficiency. This inefficiency could result in higher production costs, lower output levels, and reduced profitability, ultimately affecting their livelihoods and the broader goal of agricultural development. Furthermore, existing agricultural policies and interventions tend to overlook gender-specific challenges, thereby widening the efficiency gap between male and female farmers. While several studies have examined technical efficiency in agriculture, there is limited empirical evidence focusing specifically on the allocative efficiency of women rice farmers in this region.

Against this background, it becomes necessary to investigate how efficiently

women rice farmers in Igabi allocate their resources, identify the factors influencing their level of efficiency, and determine the extent to which inefficiencies exist. Such an inquiry will provide valuable insights for policymakers, development agencies, and stakeholders aiming to design targeted interventions that enhance productivity, improve income, and promote gender equity in agricultural resource use.It is in view of this that the study described the socio-economic characteristics of the women rice farmers and determined their allocative efficiency within the constraints of limited resources in Igabi Local Government Area of Kaduna State, Nigeria.

Methodology

The study was conducted in Igabi Local Government Area of Kaduna state. It is bounded in the East by Kaduna North L.G.A; in the South by Chikun Local Government Area; and in the West by Kaduna South local Government Area. Igabi LGA covers an area of about 1, 864km^2 and lies between latitudes 10° 25' 28" N and 11° 35 ' 53 " N and longitudes 7° 21 ' 49 " E and 7° 50 ' 00 " E. (Sarki *et al.*, 2020). It has its headquarters in Turunku and consists of twelve wards, namely: Kerawa, Rigachikun, Gadan Gayah, Kwarau, Zangon Aya, Birnin Yero, Sabon Birni Daji, Turunku, Afaka, Gwaraji, Rigasa and Igabi. The vegetation cover of the study area is uniform and monotonous typical of the NorthernGuinea Savanna Zone, experiencing the dry and wet seasons, with an average temperature of 32°c, 48% humidity and average wind speed of 11 km/h. Mohammed (2019), established that 80% of the inhabitants engage directly or indirectly inagricultural activities, growing maize, sorghum, millet, rice and rearing animals. The major tribes are Hausa, Fulani who are muslims with exception of Gbagyi who are Christians.

Sampling technique and sample size

A multi-stage sampling procedure was employed in selecting the rice farmers for the study. The first stage involved purposive selection of five wards, out of the 11wards in the Local Government namely: Riga chikun, Rigasa, Turunku, Igabi and Afaka based on the prominence of rice farming. The second stage was a purposive selection of two (2) villages from each of the five wards based on the prominence of rice production. In the final stage, a random selection of women rice farmers from the ten villages in proportionto the population (25%) of women actively involved in rice farming was done. A total of one hundred (100) women were interviewed but only 91 questionnaires were recovered and used for the study. Data were collected through the administration of questionnaire and interview scheduled to the women farmers.

Descriptive statistics such as frequency, means and percentages were used to describe the socio-economic characteristics of the farmers, such as age, marital status, education, household size and farming experience. Also,stochastic frontier production function modelwas used to examine the allocative efficiency, while Likert-type scales were used to identify the constraints associated with production systems in the study area. This method was used to identify and rank the constraints limiting rice production activity of women rice farmers in the area. A Likert scale is a psychometric scale commonly involved in research based on survey questionnaires. The range of Likert-type scale captures the intensity of their feelings for a given item (Ganiyu, 2023). The questions were captured

on a 3-point likert-type scale of Very Serious, Serious and Not Serious with a score of 1,2, and 3 respectively. A summation of scores for each respondent was determined and the point of average and above (= 2) was accepted as severe, while = 2 was not severe.

Stochastic frontier model of Cobb-Douglas functional form was adopted to assess the allocative efficiency of the respondents.

The model is specified as:$Y_i = \int(X_i ß_i) \exp (V_i+U_i)$…… (1)
where:Y_i = logarithm of the cost of production of the i^{th} farm
X_i = a vector of inputs price and output of the i^{th} farm
ß = a vector of parameter to be estimated; ∫ = suitable functional form
V = random errors that are assumed to account for measurement error of the farm
U = non-negative random error assumed to account for allocative inefficiency in production
The efficiency frontier model is expressed as:$Y_i = X_i, ß_i + (V_i+U_i)$ 1=1…N, …… (2)
Where $U_i = (Z_i S)$
X_i = a (I x K) vector of production inputs prices of the i^{th} farm
ß= a (K x I) vector of unknown parameters to be estimated
V_i = random errors which are assumed to be normally distributed with mean zero and variance d
U_i = non- negative random variables which defines how the farm operates above the cost frontier. It is closely related to the cost of technical inefficiency and are assumed to be independently distributed of the V_i
Explicitly,
$\ln C = ß_0 + ß_1 \ln Y + ß_2 \ln P_1 + \ldots + ß_k \ln P_{ki} + V_i - U_i$

Where: *C* = Total cost of production (₦); Y = Output level (Kg); P_1= Cost of land rent(₦)
P_2 = Labour cost(₦); P_3 = Seed cost(₦); P_4 = Cost of fertilizer (₦);
P_5 = Agrochemicals cost(₦); P_6 = Capital inputs (₦); V_i = Random errors; U_i = Cost inefficiency

Theory of Allocative Efficiency among Women Rice Farmers in Kaduna State, Nigeria, following presentations by Aigner, Lovell and Schmidt (1977); Nwahia *et al*, (2020) we assume that rice farmers utilize a vector of conventional inputs, *Xi* to produce a single output *Y*. The household incurs production risk because rice yield is affected by uncertain climatic conditions. This risk is captured by a random variable, *vi*, whose distribution is exogenous to the rice farmers action and other risks that might occurred as a result of the rice farmers inefficiency, which is captured by *ui* and its distribution is endogenous to the rice farmers action. Let ß be the corresponding parameter of the conventional inputs and ei be the composite error term i.e, *vi + ui*then the stochastic production function is given by *Y = f(Xi:ß) + ei* where *Y* is output, *Xi* are standard inputs and ß are the parameters. Therefore, the technical efficiency of production is given as *TEi =exp(-ui) = Y/Y**. Where *Y* is the observed output and *Y** is the maximum feasible output. Allocative efficient implies that the firm was able to equate the marginal value product *(MVPx)* of each resources employed to its unit cost *(Px)*. *MVPx*is obtained, when slope of production function (marginal product *(MPx))* is equal to the slope of the =Iso-Profit line which is the ratio of the price of the factor inputs to the price of output *(Px/Py)* as derived below: *MPx = Px/Py = MPx × Py = Px*. Therefore, *MVPX = Px*. where: *MVPX = MPx× Py*. *MVPX* is the marginal value product of the input.

MPx = dQ/dX, and based on the double log functional form is given by *MPP=b(Yi/Xi)*. Where b is the coefficient of the variable, Yi is the geometric mean of output and Xi is the geometric mean of the inputs. Hence, for an optimum input utilization *MVPx*must equals *Px*. Then, if *MVPx> or <Px*, there is disequilibrium in the use of inputs, that is under-utilization (over utilization), hence the use of such input must be increased (decreased) in order to improve the allocative efficiency of the input by the farmer.

Result and discussion

Socio-Economic characteristics of small holder women rice farmers

The socio-economic characteristic of women rice producers examined in the study showed that the average age of the farmers is 40 years. The age range of the farmers shows that 33% of the women rice farmers were 30 years and below. This is followed by 26.4%, 23.1%, 14.3% and 2.2% of the farmers who are in the age range of 31-35years, 46 - 50years, 41 - 45years and 36 - 40years respectively. This implies that the women rice farmers are in their youthful age. This is in line with Ganiyu *et.al* (2018) on the determinant of rice demand in Birnin Gwari Agricultural zone of Kaduna State. The marital status in table 1 showed that majority (72.5%) are married, 17.6% are single while 9.9% are divorced. This means that most of the farmers will have the advantage of using family labour for rice production. This agrees with Ojumu *et al*. (2024). Also, the educational level revealed that 40.7% of the women rice farmer had tertiary education. This is followed by those with primary education 31.9% and secondary education 17.6%. Only 8.8% of them had no formal education while 1.1% had Quranic education. This means that the farmers can read and write and as a result will be able to find out new innovation that will improve their production as opined by Ojumu *et al*. (2024).

The study further shows that majority (89%) had household size that ranges between 1-5 people while the remaining (11%) had household size of between 6 - 10 people. This underscores the use of family labour for farming in the area. This corroborates the findings by Obekpa *et al*. (2022) that marketers of garri in Kaduna metropolis, had 1 – 5 family members.Also, Olagunju *et al.* (2024)observed that rural women engaged in rice production in Igabi LGA, Kaduna State had average of 5 family members, and mainly (80%) used hired labour. The distribution by farming experience showed that about half (53.8) of them had between 9-13 years of experience in rice farming. This was closely followed by 40.7% who had more than 13 years' experience. Only 5.5% had between 4-8 years of farming experience. The distribution of the women farmers by occupation showed that most (58.2%) of them are artisan, followed by farmers (40.7%). Only 1.1% are civil servants. Generally, the respondent can also generate their income from other sources since they have other skills as opined by Olagunju *et al.* (2024), on the adoption of rice farming technology among rural women in Igabi LGA., Kaduna State. Most (83.5%) of the women had between 2 – 4 hectares of land for rice production. Only 15.4% and 1.1% had > 4, and < 2 hectares devoted to rice production respectively. This means that they are small holders with limited access to land, and only produce at subsistence level due to their involvement in other livelihood activities apart from farming.

Table 1: Distribution of farmers by Socio-economic characteristics

Characteristics	Frequency	Percentage	Average
Age			40
=30	30	33.0	
31 – 35	24	26.4	
36 – 40	2	2.2	
41 – 45	13	14.3	
46 – 50	21	23.1	
>50	1	1.1	
Marital Status			
Married	66	72.5	
Single	16	17.6	
Divorce	9	9.9	
Education			
Tertiary	37	40.7	
Secondary	16	17.6	
Primary	29	31.9	
Quranic	1	1.1	
Non-formal	8	8.8	
Household size			**6**
1 – 5	81	89.0	
6 – 10	10	11.0	
Years of farming experience			**12**
4 – 8	5	5.5	
9 – 13	49	53.8	
>13	37	40.7	
Occupation			
Artisan	53	58.2	
Farming	20	40.7	
Civil servant	1	1.1	
Farm size(ha)			
<2	1	1.1	
2 – 4	76	83.5	
>4	14	15.4	
Total	**91**	**100**	

Income and working hours

As shown in Table 2 majority (62.7%) of the women earned between ₦50000 - ₦150000. This is followed by 35.2% and 2.2% who earned between 151000 - 250000 and 251000 – 350000 respectively. The average income of the women farmers from rice farming is ₦200333.33 per season. The result further shows the working hours of the women farmers. Majority (73.6%) of them work within the range of 4 – 6 hours on farm. Only 17.6%, 7.7% and 1.1% work between 7 – 9

hours, 1 – 3 hours and 10 – 12 hours respectively. This implies that the women rice farmers have limited financial capacity to meet basic needs and are highly vulnerable to shocks like crop failures or price fluctuations. Also, it reflects low productivity per hour due to traditional farming methods in rice cultivation. This corroborate the submission of Ojumu *et al.* (2024) that male farmers were more economically efficient than their female counterparts in rice production.

Table 2: Distribution of the women rice farmers by income and working hours/ season

Income (₦)	**Frequency**	**Percentage**
50000 – 150000	57	62.7
151000-250000	2	2.2
251000-350000	32	35.2
Average	200,333.33	
Work hour		
1 – 3	7	7.7
4 – 6	67	73.6
7 – 9	16	17.6
10 – 12	1	1.1
Total	**91**	**100**

Rice cultivation method adopted by the farmers

The cultivation method employed by the women farmers showed that swamp rice is chiefly (81.3%) cultivated. Only 17.6%, and 1.1% of the respondents cultivate upland and irrigated rice respectively. This implied that the traditional method of rice cultivation in swampy areas that are rain fed is hitherto used by the women rice farmers, thus accounting for their production inefficiency. This is in tandem with Ojumu *et al*. (2019), that inadequate rain constrained rice cultivation among smallholders' rice farmers due to their traditional cultivation method, thereby making them inefficient.

Table 3: Distribution of farmers by cultivation method adopted in the area

Cultivation method	**Frequency**	**Percentage**
Swamp	74	81.3
Upland	16	17.6
Irrigation	1	1.1
Total	91	100

Allocative Efficiency of the Women Rice Farmers in the study area.

The maximum Likelihood estimates of the stochastic cost function for female rice farmers in the study area are presented in Table 4. The result showed that gamma (y= 0.356) was statistically significant at 1% level, implying a good fit of the model and the correctness of the assumption of the composite error term. The results further showed that the coefficients of all the variables included in the cost function had the

expected positive signs. This implies that there is a positive relationship between the total cost of rice production and the cost of these variables. The variables identified as having a significant influence on the cost of rice production by female farmers include the labour cost, seed cost, transport cost, fertilizer cost and rent on land.This is in line with Effiong *et al*. (2015), who opined that total cost significantly influenced participation in rice production in Bende LGA, Abia State.

The result further revealed that the factors contributing to the allocative in-efficiency of the women rice farmers include age, education, household size, and credit facilities. The result indicated that the age of women rice farmers had negative and significant relationship with production at 1%, implying that inefficiency reduces with increase in age of rice farmers, probably due to production experience. Also, education of the women rice farmers had negative but statistically significant relationship with production at 10% level. This shows the critical role education plays in influencing the efficiency of women rice farmers. This agrees with Kolawole and Michael (2021) who observed that education had a significant determinant of the efficiency of rice farmers. The study also showed that household size was another determinant (5%) of the allocative efficiency of the women rice farmers. Its coefficient had a negative sign which implies that the inefficiency of the women rice farmers reduces with increase in the size of the household. This establishes the fact that most women rice farmers operate at a subsistence level through reliance on family labour for most of the farming activities. The conforms with the findings by Jirgi *et al.*, (2021) that women rice farmers often grow small plots of farmland. Also, the Table further showed that Access to credit facilities was one of the most critical factors influencing the allocative efficiency of women rice farmers in the area. Access to credit facilities had the expected negative sign and was statistically significant at 5% level. This implies that women rice farmers access to credit facilities will improve their efficiency. This is in tandem with the finding of Kolawole and Michael (2021) on economy analysis of rice production by small-holder women farmers in Adamawa state, Nigeria.

Table 4: Maximum likelihood Estimate of the Parameters of the stochastic frontier Cost Function (allocative efficiency) for Female Farmer

Variables	Coefficient	Standard Error	t-ratio
Constant (ß)	-7.884	4.054	-1.945*
Output	-0.019	0.001	14.684**
Cost of labour ($ß_1$)	0.243	0.111	2.181**
Cost of seed ($ß_2$)	0.218	0.056	3.905***
Cost of transport ($ß_3$)	0.141	0.064	2.201**
Cost of fertilizer ($ß_4$)	0.001	0.000	4.665***
Cost of agrochemicals ($ß_5$)	0.010	0.001	-7.485
Rent on land ($ß_6$)	0.031`	0.015	2.053**
Inefficiency Factors			
Age(d_1)	-0.003	0.001	-3.127***

Education(d_2)	-1.030	0.431	-2.391*
Farming experience(d_3)	0.836	1.333	0.627
House-hold size(d_4)	-0.069	0.034	-2.035**
Extension services(d_5)	0.436	0.517	-0.843
Credit facilities(d_6)	-1.000	0.324	3.091**
Sigma squared(d_2)	0.426	0.058	7.284 ***
Gamma (y)	0.356	0.030	12.035**
Log likelihood function		162.73	

*** = 1%; ** = 5%; * = 10%

The estimated parameter of allocative efficiency presented in Table 4 showed that the coefficients of seed cost, fertilizer cost, labour cost, transport cost, and land rent were statistically significant at 1% and 5% level of probability respectively. This means that these variables mostly determine the total cost of rice production by women farmers. An increase in these inputs will lead to an increase in the total cost of rice production by the women farmers. This agrees with Nwahia *et al*. (2020), on analysis of technical, allocative and economic efficiency of rice farmers in Ebonyi State, Nigeria.

Constraints Faced by Smallholder Women Rice Farmers

The women rice farmers distribution by constraints faced in production showed that inadequate processing facilities ranked 1st.table what? This is followed by incidence of pest and diseases, yield losses to animals and flood, high prices of inputs, low prices of output, inadequate land, poor extension contacts, lack of high-quality seed, poor infrastructure and inadequate capital which was ranked 2nd, 3rd, 4th, 5th,6th, 7th, 8th, 9th, 10th,11th, and 12th respectively. The implication is that processing facilities limit women rice farmer productivity in the study area. This finding consolidate the submission by Ganiyu *et al* (2018), but contradicts the submissions of Ojumu *et al*. (2024), where inadequate rain was ranked 1st in the list of farmers constraints to rice production in Niger State.

Table 5: Distribution of farmers by Constraints of rice farming

Constraints	*Frequency	Percentage	Rank
Inadequate processing facilities	79	12.90	1st
Incidence of pests and diseases	75	12.25	2nd
Yield losses to animals and flood	60	9.80	3rd
High price of inputs	55	8.99	4th
Low prices of output	54	8.82	5th
Inadequate land	48	7.84	6th
Poor extension contacts	47	7.68	7th
Land tenure problem	42	6.86	8th
High labour cost	42	6.86	8th
Lack of high quality seed	41	6.60	10th

Poor infrastructure	37	6.05	11th
Inadequate capital	32	5.23	12th
Total	612	100.0	

*Multiple Response Allowed

Conclusion: This study provided more evidence of inefficiency in rice production by women farmers. Women farmers could reallocate resources to achieve more efficiency, thereby adjusting input combinations to levels that achieve minimum cost while maximizing their output. The women rice farmers can be more productive and efficient by the interventions that will make land more accessible to women while equally focusing on subsidizing inputs costs.

Recommendations

Based on the findings the following recommendations were made.

Since the cost of inputs significantly influence allocative efficiency of the women rice farmers, government should subsidize the cost of inputs andextend the support provided to rice farmers through Anchor Borrowers Scheme to women rice farmers in the study area.

The study identified inadequate processing facilities as top of farmers list of constraints, thus, farmers should form themselves into cooperatives societies so that they take advantage of group to reduce high prices of inputs and tackle inadequate processing facilities.

Extension department of the ministries of agriculture should intensify efforts to educate women rice farmers about improved technologies for rice farming that will improve productivity and address losses to pest and flood.

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